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Willow Species of Disturbed Sites in the Sub-Boreal Spruce Zone in North-central British Columbia

by
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1 INTRODUCTION

At least 42 species of willows (the genus *Salix*) are found in British Columbia (Brayshaw 1976), and at least 14 of these occur in varying degrees of abundance on sites disturbed by forest industry activities in the Sub-Boreal Spruce Biogeoclimatic Zone (SBS) of north-central British Columbia.

Willow species are relatively shade-intolerant, and many upland willows —uncommon under mature tree canopies — find optimum conditions for growth (along with other forage species) on disturbed sites where mature forest has been harvested or burned.

Willows provide a principal source of moose browse for most of the year, as well as food for deer, rodents, snowshoe hares, and birds. Overstory removal, mechanical site preparation, and prescribed burning may all increase willow abundance, by improving conditions for germination and growth and by promoting sprouting (Haeussler and Coates 1986). Logging activity in the SBS has thus increased the abundance of ungulate forage.

Willows can grow rapidly initially and thus compete with crop trees by shading them out. Whether treated as primary competing species or, more commonly, as part of a competing species complex, willows are often subjected to the post-planting brush control activities of cutting or herbicide application. Mechanical cutting can promote vigorous sprouting, thereby increasing willow abundance and improving wildlife habitat. Willow responses to herbicide application have been variable (Coates and Haeussler 1986; Balfour[1]; Lloyd[2]), partly because of the difficulty in identifying species.

The various willow species are not always easy to distinguish from one another, especially for non-botanists. Consequently, the

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[1] Balfour, P. 1987. Effects of forest herbicides on wildlife forage species in British Columbia. Unpublished manuscript. B.C. Ministry of Environment and Parks, Wildlife Branch, Victoria, B.C. 59 p. + appendices.

[2] Lloyd, R.A. 1986. Assessing the impact of glyphosate (Roundup®) and liquid hexazinone (Velpar®) on moose browse species. Unpublished manuscript. B.C. Min. For., Victoria, B.C. 21 p. + appendices.

genus *Salix* has sometimes been treated in both forestry and wildlife research as a single entity, even though different species of the genus have different ecological characteristics and different values as wildlife forage, and may be expected to respond differently to various treatments.

Willows, then, constitute a group of plants which represent both critical moose browse and potential brush problems for forestry. A number of studies on responses of willow species to various site preparation techniques are currently under way, but much basic information on willow autecology in the SBS of north-central British Columbia has been lacking.

The purposes of this guide are:

1. to identify the willow species that occur on disturbed sites in north-central British Columbia;
2. to provide descriptions and keys which researchers may use to recognize these species either in the field or in the herbarium;
3. to describe the ecological and geographical patterns of distribution and abundance of these species;
4. to describe the patterns of seasonal change in the vegetative and reproductive stages of the most abundant willow species; and
5. to characterize each species according to its use as winter moose forage.

2 THE STUDY AREA

In the Prince George area of north-central British Columbia, four subzones of the SBS — the SBSdw3 (Cluculz dry warm SBS, formerly known as the SBSk3); the SBSmk1 (Mossvale moist cool SBS, formerly the SBSe2); the SBSwk1 (Willow wet cool SBS, formerly the SBSj1); and the SBSvk (very wet cool SBS, formerly the SBSf) — provide an ecological transect from relatively dry and warm in the west to relatively wet and cool in the east (Figure 1). Each of these subzones supports a commercially important forest resource, and in each the willow growth in the clearcut areas provides winter forage for moose.

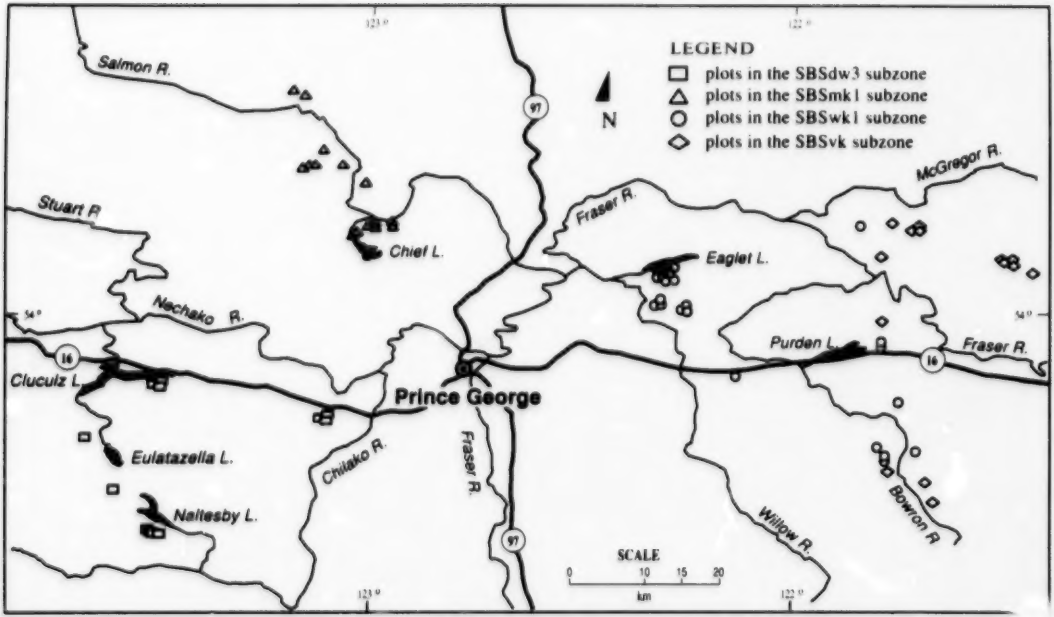

FIGURE 1. Map of the study area showing plot locations by biogeoclimatic subzone.

Sample plots were located in the above four subzones in an area lying between 123° 40' and 121° 26' west longitude, and between 53°35' and 54°26' north latitude.

3 METHODS

Preliminary reconnaissance of the area was carried out in the fall of 1987. Forest roads in each of the four subzones to be studied were driven and potential sites for willow study plots were identified, based on the following criteria: site disturbance by clearcut logging or site preparation; presence of willows; potential competition between willows and conifer seedlings; potential use of willows as moose forage; and a varied representation of ecological site conditions. Willow specimens were collected during this period and sent to the National Herbarium in Ottawa for identification.

In the summer of 1988, 65 formal sample plots were centre-staked and corner-flagged at sites selected the previous autumn. Plot size was generally 100 m^2 (10 x 10 m), but larger or smaller plots were used where vegetation was sparser or denser than normal, and some plots were rectangular to account for terrain features. Twelve plots were located in the SBSdw3 subzone, 15 in the SBSmk1, 24 in the SBSwk1, and 14 in the SBSvk.

At each plot, site and vegetation relevé information were recorded on standard Ministry of Forests/Ministry of Environment coding forms. Site information recorded on the forms included: latitude, longitude, aspect, slope, elevation, biogeoclimatic zone and subzone, topographical position, site surface shape, soil texture, ecological moisture regime, thickness of humus layer, percent cover of plot by different surface substrate types, and disturbance history. Vegetation data consisted of percent cover of each vascular plant species present, with the cover of willow species recorded separately in five height strata (>2.5 m, 1.5-2.5 m, 1.0-1.5 m, 0.5-1.0 m, and <0.5 m), as well as in total.

For each willow species, the amount of available browse that had been eaten by moose the previous winter was estimated and coded on the vegetation forms according to the five-class Utilization Rating system of Walmsley *et al.* (1980): 0 = No utilization; 1 = Trace (1-5%); 2 = Light (6-25%); 3 = Moderate (26-50%); and

4 = Heavy (>50%). A sixth class of 5 = Severe (>75%) was also added.

Within each subzone, three to four selected plots were visited at regular intervals between May 17 and September 10, 1988, to record the phenological development of the four most abundant and widespread willow species. The system of coding phenological information was modified from one recommended by Dierschke (1972) and is given in Table 2 (see page 61).

The field data were keypunched by staff of the Ministry of Forests and Ministry of Environment in Victoria and were summarized and tabulated by means of programs maintained by both ministries.

Specimens of each willow species were collected and the identifications verified by the National Herbarium. The willow specimens are to be deposited at the Ministry of Forests Regional Herbarium in Prince George and at the Royal British Columbia Museum Herbarium in Victoria.

4 NOTES ON USING THE KEYS

4.1 General Comments

Definitive identification of plant species generally requires close examination of the reproductive parts, as it is mainly the reproductive material upon which technical species descriptions are based. Willows, however, generally flower early in the year, and the reproductive parts (or catkins) seldom persist on the plant past June or July. Furthermore, the immature shrubs of recently disturbed sites may not flower at all. Because of these situations, field researchers may be unable to identify willow specimens, which have lost their catkins or never had any. This guide therefore provides two keys to the willow species; one based on characteristics of the leaves and stems — the vegetative features; and one based on reproductive features.

A key based on vegetative characters may not be entirely reliable, since these characters are often highly variable and qualitative, requiring a subjective and imprecise assessment of the character state. Furthermore, vegetative characters alone

cannot usually be used to identify the species. It is therefore always desirable to try to examine and collect catkin-bearing specimens, and to use the key based on reproductive characters.

In using either key, users are advised to read both branches of a key couplet before deciding which branch best describes the specimen. To check decisions about species identification, refer to the detailed species descriptions in Section 7.

4.2 Using the Key Based on Leaf and Stem Characters

This key is designed for field use and requires no more equipment than a hand lens. The use of a hand lens is essential, since correct identification sometimes depends on the accurate observation of minute hairs.

Except as noted, the key assumes the user will examine typical mature, mid-season leaves. The leaves of many species look similar in spring, when distinguishing characteristics of hairiness, vein pattern, and coloration have not fully developed. In the fall, the leaves may lose their distinctive qualities as they coarsen, shed their hairs, and change color. Vigorous sprouts have rather atypical leaves that may be difficult to key.

The key is based on material collected within the study area and in disturbed-site habitat. Some descriptive elements in the key (e.g., color of veins) may not match material collected from other geographical areas or other habitats (e.g., forest understory).

The wide variation observed in willow vegetative characteristics has been allowed for in the key, but even so, some specimens may not match the key entries in every respect. Use of the detailed species descriptions in the Section 7 may resolve some ambiguities.

One species, *S. myrtillifolia* var. *cordata*, is extremely rare on the study sites (found at only one location) and the material collected did not permit any generalization of its vegetative features. It has therefore been omitted from the vegetative key, where it would probably key out to *S. barclayi*. The species has, however, been included in the key based on reproductive characters.

4.3 Using the Key Based on Reproductive Characters

Willows come in two forms: those which bear pollen-producing catkins and those which bear fruiting, seed-producing catkins. (The terms "male" and "female" may be applied, respectively, but they are not strictly accurate.) The fruiting catkins provide the basis for the key descriptions and are thus essential for species identification. The pollen-bearing catkins can sometimes be helpful, but are not essential.

Use of this key will sometimes require measurement of rather minute and obscure floral parts, which is not easy in the field. A hand lens and a ruler scaled in millimetres will be required. In general, however, it will be preferable to examine the floral parts with the aid of a dissecting microscope.

Willow flowering is well under way by mid-May in the study area. Two common species, *S. discolor* and *S. scouleriana*, will have completed their flowering cycle and dropped their catkins by early June in some locations (see Fig. 5). Fieldwork therefore needs to be done early in the growing season so that the material needed for positive identification of these species can be collected.

A diagram of a typical willow flower, illustrating the floral structures referred to in the key, is provided in Appendix 1.

5 A FIELD KEY TO THE WILLOW SPECIES OF DISTURBED SITES IN NORTH CENTRAL BRITISH COLUMBIA, USING LEAF AND STEM CHARACTERS

1a. Leaf undersides having a dull, pale bluish- or whitish-green coating, or a densely hairy coating, or both

2a. Leaf margins not at all toothed, or with only a few minute and irregular projections, or shallowly scalloped

3a. Leaves sparsely to densely hairy underneath

4a. Young stems smooth, dark-purplish, hairless, coated with a bluish-white waxy bloom that rubs off easily; leaf undersides ± satiny-hairy, sometimes thickly long-hairy, the hairs white or rust-tinged; lateral veins not conspicuous, ± weak and irregular ..... *S. drummondiana*

4b. Young stems sparsely hairy to densely fuzzy, lacking a bluish-white waxy bloom; leaf hairs various

5a. Undersurface of leaf densely covered with short white hairs, imparting a characteristic satiny or pearly lustre; mid-vein and lateral veins cream- to cherry-red underneath, robustly raised up underneath, in a conspicuous regular herringbone pattern ..... *S. sitchensis*

5b. Leaf undersurface variously hairy but not lustrous; mid-vein and lateral veins seldom red underneath, not making a conspicuous, raised, regular herringbone pattern

6a. Leaf stalks and young stems ± velvety with short, erect hairs; on older material, often at least a few of the hairs of leaf undersides rust-colored, rusty hairs sometimes concentrated along the veins or in small points ..... *S. scouleriana*

6b. Hairs of leaf stalks and stems ± silky, woolly or matted rather than erect-velvety; leaf hairs white only

7a. Leaves commonly ± sharp-tipped; lateral veins and veinlets becoming raised up underneath in a ± prominent netlike pattern, typically cream-colored or the same pale green as the background ..... *S. bebbiana*

7b. Leaves often ± blunt-tipped; veinlets seldom raised up; veinlets, and often the lateral veins, appearing darker green underneath than the pale background (the laterals becoming ± weakly pale-raised on older leaves) ..... *S. glauca* var. *villosa*

3b. Leaves essentially hairless underneath

8a. Leaf stalks and young stems ± velvety with short erect hairs ..... *S. scouleriana*

8b. Leaf stalks and young stems not velvety, with short erect hairs, often hairless

9a. Stipules usually conspicuous; leaf bases often rounded to heart-lobed; leaf stalk and mid-vein usually becoming cherry-red, at least toward base; previous year's stems mostly shiny purplish with greyish, peeling areas ..... *S. prolixa*

9b. Stipules mostly inconspicuous (except on vigorous shoots); leaf bases often acute-angled, never heart-lobed; leaf stalk and especially the mid-vein seldom red; previous year's stems seldom peeling

10a. Leaves dull to ± shiny on top; lateral veins mostly ± widely and irregularly spaced, tending to wander; common

11a. Lateral veins and veinlets tending to become raised up underneath in a prominent netlike pattern, typically cream-colored or the same pale green as the background ..... *S. bebbiana*

11b. Veinlets not raised up underneath (though sometimes the lateral veins becoming ± raised up on older leaves); veinlets darker than the background ..... *S. discolor*

10b. Leaves usually shiny on top; lateral veins mostly narrowly and regularly spaced, parallel; rare .... *S. planifolia* ssp. *planifolia*

2b. Leaf margins distinctly, regularly and numerously toothed

12a. Teeth of leaf margins distantly spaced, ± elongated along the margin and projecting shallowly, not sawlike, except sometimes ± large and sawlike on vigorous shoots

13a. Leaves sparsely to densely hairy underneath

14a. Leaf stalks and young stems ± velvety with short erect hairs; on older leaves, often at least a few of the hairs of leaf undersides rust-colored, rusty hairs sometimes concentrated along the veins or in small points; lateral veins mostly thinly raised-pale underneath, the veinlets only weakly so ..... *S. scouleriana*

14b. Leaf stalks and young stems ± silky-, woolly- or matted-hairy rather than erect-velvety; leaf hairs white only; lateral veins and veinlets typically raised underneath in a prominent netlike pattern ..... *S. bebbiana*

13b. Leaves essentially hairless underneath

15a. Leaf stalks and young stems hairless, or sometimes long silky-hairy; leaf undersurface generally ± smooth except for the mid-vein, the lateral veins not much raised-pale (except sometimes on older leaves)

16a. Leaves dull to ± shiny on top; lateral veins mostly ± widely and irregularly spaced, tending to wander; common.... .... *S. discolor*

16b. Leaves usually shiny on top; lateral veins mostly narrowly and regularly spaced, parallel; rare .... *S. planifolia* ssp. *planifolia*

15b. Leaf stalks and young stems with woolly, velvety or silky hairs; usually the leaf undersurface not smooth, the lateral veins ± raised-pale

17a. Leaf stalks and young stems velvety with short, erect hairs; lateral veins on leaf undersurface mostly thinly raised-pale, the veinlets only weakly so *S. scouleriana*

17b. Leaf stalks and young stems ± silky-, woolly- or matted-hairy rather than short-velvety; lateral veins and veinlets typically raised underneath in a prominent netlike pattern ..... *S. bebbiana*

12b. Teeth of leaf margins closely spaced, small to minute, finely sawlike

18a. Young stems smooth, dark-purplish, hairless, coated with a bluish-white waxy bloom that rubs off easily; leaf undersides usually ± satiny-hairy, sometimes thickly long-hairy ..... *S. drummondiana*

18b. Stems various but normally lacking a bluish-white waxy bloom; leaves hairless underneath, or only sparsely and inconspicuously hairy

19a. Stipules (when present) mostly large and leafy; leaves often tapering to a long, narrow-pointed tip (except sometimes ± blunt-tipped, especially when young); stems hairless and shiny

20a. One to several glands (small globular or stalklike projections) around the juncture of the leaf stalk with the blade; base of blade not heart-lobed; leaf often very finely and inconspicuously hairy underneath; leaf stalk and underside of mid-vein seldom becoming red; young stems mostly caramel-colored, the previous year's stems not peeling; bud scales large, orange, duckbill-shaped .... *S. lucida* ssp. *lasiandra*

20b. Glands lacking at juncture of leaf stalk and blade; base of blade sometimes heart-lobed; leaf hairless underneath; leaf stalk and underside of mid-vein usually becoming cherry-red, at least toward the base; young stems mostly purplish, the previous year's stems greyish, peeling; bud scales mostly smaller, purplish, narrow ..... *S. prolixa*

19b. Stipules mostly small and inconspicuous, or absent; leaf tips not long and narrow-pointed; stems various

21a. Unfolding leaves notably membranous, delicate and translucent, yellow-green to sometimes reddish; early leaves ± broadly egg-shaped, sometimes with rounded tips and heart-lobed bases (later leaves more elliptic); lateral veins and veinlets becoming ± prominently raised up in a netlike pattern underneath, ± impressed above ..... *S. pyrifolia*

21b. Leaves various but not all as above; leaves not egg-shaped or rounded with a prominently raised netlike vein pattern underneath (except sometimes veins becoming raised on old leaves)

22a. One to several glands (small globular or stalklike projections) around the juncture of the leaf stalk with the blade; leaf often very finely and inconspicuously hairy underneath; young stems mostly caramel-colored; bud scales large, orange, duckbill-shaped ..... *S. lucida* ssp. *lasiandra*

22b. Glands lacking at juncture of leaf stalk with blade; leaves mostly hairless underneath; young stems not usually caramel-colored; bud scales not large, orange, duckbill-shaped

23a. Leaf stalk and underside of mid-vein tending to become cherry-red, at least toward the base; leaf bases often heart-lobed; young stems mostly shiny-purplish, the previous year's stems greyish, peeling ..... *S. prolixa*

23b. Mid-vein generally yellow or green, the leaf stalk becoming brownish; leaf bases not heart-lobed (except rarely in *S. barclayi*); previous year's stems not normally greyish, peeling

24a. Leaves light yellowish-green above, mostly about 2.5-3.0 times longer than wide, sometimes ± delicate; mid-vein not notably stout underneath; lateral veins and veinlets darker yellow-green against the pale background underneath, but often not conspicuously so; margins mostly finely or weakly toothed, but teeth sometimes lacking

25a. Expanding leaves yellowish-green, with white hairs on both surfaces and the young leaf stalks ± white-silky; some hairiness tending to persist on the upper surface, especially along the mid-vein (but sometimes the leaves becoming completely hairless) . ..... *S. barclayi*

25b. Expanding leaves tending to be reddish-purple, at least toward the base; leaves hairless (or very nearly so) on all parts, even when young ..... *S. farriae*

24b. Leaves deeper green above, mostly about 4 times longer than wide, ± firm or leathery; mid-vein stout and prominent underneath; veinlets making a conspicuous dark green filigree against the pale background underneath; margins tending to be robustly glandular-toothed, but teeth sometimes lacking .... *S. maccalliana*

1b. Leaf undersides green, without a dull, pale coating; leaves hairless or only sparsely hairy underneath

26a. Leaves light yellowish-green above, mostly about 2.5-3.0 times longer than wide, sometimes ± delicate; mid-vein not notably stout underneath; lateral veins and veinlets darker yellow-green against the paler background underneath, but often not conspicuously so; margins mostly finely or weakly toothed, but teeth sometimes lacking

27a. Expanding leaves yellowish-green, with white hairs on both surfaces and the young leaf stalks ± white-silky; some hairiness tending to persist on the upper surface, especially along the mid-vein (but sometimes the leaves becoming completely hairless) ..... *S. barclayi*

27b. Expanding leaves tending to be reddish-purple, at least toward the base; leaves hairless (or very nearly so) on all parts, even when young .... *S. farriae*

26b. Leaves deeper green above, mostly about 4 times longer than wide, ± firm or leathery; mid-vein stout and prominent underneath; veinlets making a conspicuous dark green filigree against the paler background underneath; margins tending to be robustly glandular-toothed, but teeth sometimes lacking..... *S. maccalliana*

6 A KEY TO THE WILLOW SPECIES OF DISTURBED SITES IN NORTH CENTRAL BRITISH COLUMBIA, USING REPRODUCTIVE CHARACTERS

1a. Catkins borne directly on the twigs, not terminating a leafy branchlet (though sometimes with a few small leaflike bracts at the base), appearing before the leaves

2a. Young stems smooth, hairless, dark purplish, coated with an easily removed bluish-white waxy bloom; capsules ≤5mm long ..... *S. drummondiana*

2b. Young stems hairy or hairless, variously colored, lacking pale waxy coating; capsules ≥5 mm long

3a. Stigma lobes ≥ the style; stipe sometimes > 1 mm long.

4a. Catkins ± robust, up to 12 cm long x 3 cm thick, and the capsules up to 12 mm long; stipe 1.5-2.5 mm long, bract 2-3 mm long; young stems and leaf stalks hairless, or silky-hairy early in season, but not short erect-velvety .... *S. discolor*

4b. Catkins smaller, up to about 6.0 cm x 1.5 cm; capsules mostly ≤8 mm; stipe 0.5-2.0 mm long; bract 4-5 mm long; young stems and leaf stalks having short erect velvety hairs .... *S. scouleriana*

3b. Stigma lobes < the style; stipe ≤ 1 mm long .... *S. planifolia* ssp. *planifolia*

1b. Catkins terminating short leafy branchlets, appearing with (or shortly before) the leaves

5a. Capsules hairy

6a. Stipe 2-5 mm long, >the bract; stigma lobes sometimes > the style; leaf lateral veins and veinlets ± raised underneath in a netlike pattern..... ..... *S. bebbiana*

6b. Stipe usually > 2 mm, > the bract; stigma lobes mostly > the style; leaf veinlets not usually raised underneath

7a. Catkins slender, mostly <1 cm thick; bracts brown to dark brown; leaves satiny-lustrous underneath with dense short white hairs; young stems velvety-woolly; stamens one per flower ..... *S. sitchensis*

7b. Catkins mostly > 1 cm thick; bracts yellow to brown; leaves hairy to hairless underneath but not satiny-lustrous; young stems ± hairy but not velvety-woolly; stamens two per flower

8a. Leaves usually lacking dull pale waxy coating underneath, the underside thus yellow-green and ± shiny, hairless (or reddish-hairy when young); the leaf about 4 times longer than wide, with a stout yellow mid-rib and (usually) toothed margins ..... *S. maccalliana*

8b. Leaf undersides with well-developed dull pale waxy coating and ± abundant white hairs, the leaf about 1.5-3.0 times longer than wide, the mid-rib not yellow and stout, the margins not toothed..... *S. glauca* var. *villosa*

5b. Capsules hairless

9a. Mature leaves lanceolate with large, conspicuous (eventually deciduous) stipules and ± prominent glands at juncture of blade and leaf stalk; bud scales large, orange, duckbill-shaped; two nectar glands per flower; two stamens per flower, usually 5 ..... *S. lucida* ssp. *lasiandra*

9b. Leaves and bud scales various, but not as above; one nectar gland per flower; two stamens per flower

10a. Stipes (1-)2-4 mm long, mostly several times longer than the glands; bracts 1-2 mm long; young stems shiny-hairless, mostly reddish to purplish; leaf bases sometimes heart-lobed, leaves having dull pale waxy coating underneath

11a. Unfolding leaves usually reddish and opaque; stipules becoming large and conspicuous (eventually deciduous); previous year's stems having greyish, peeling patches; catkin axis often notably long-hairy; bracts about 1 mm long, brown, basally hairy; stamens joined toward the base ..... *S. prolixa*

11b. Unfolding leaves yellowish (sometimes reddish) and membranous-translucent; stipules minute or absent; previous year's stem usually lacking greyish, peeling patches; catkin axis short-hairy; bracts up to 2 mm long, tan-colored and long-hairy to the tip; stamens not joined ..... *S. pyrifolia*

10b. Stipes mostly <1.5 mm long, about twice as long as the glands; bracts variable; young stems hairy, at least initially, not shiny, often greenish; leaf bases rarely heart-lobed; leaves sometimes lacking dull pale waxy coating underneath

12a. Leaves usually having dull pale waxy coating underneath; stipules small and inconspicuous (except on vigorous shoots)

13a. Unfolding leaves yellowish-green, ± white-hairy on both sides (sometimes the hairs scarcely evident); branchlet hairs somewhat erect; pistils usually greenish ..... *S. barclayi*

13b. Unfolding leaves often reddish toward the base, hairless underneath but with a few white or reddish hairs on the upper surface, the mid-vein and leaf stalk sometimes short white-hairy; branchlet hairs often pressed ± flat against the stem; pistils often red-tinged ..... *S. farriae*

12b. Leaves generally lacking dull pale waxy coating underneath, the underside thus yellow-green and ± shiny; stipules conspicuous, up to 5 mm long, or absent on older leaves ..... *S. myrtillifolia* var. *cordata*

7 DESCRIPTIONS OF THE WILLOW SPECIES

The genus *Salix*, the willows, may be distinguished from the related aspens, poplars, and cottonwoods by the absence of a terminal bud, the enclosure of the bud in only a single scale, and the round cross-section of the stem pith.

This section provides descriptive summaries of each of the 14 willow species that were found to occur on disturbed sites in the study area. Besides physical descriptions and illustrations, each summary includes information on the geographical distribution and abundance of the species on the study sites, on the ecological site conditions (soil texture and ecological moisture regime) at the sites where the species was found, and on the estimated use of the species as winter moose browse.

The species descriptions are based mainly on material collected from disturbed sites within the study area. Under different geographical or habitat conditions, the appearance of some species may vary somewhat from the descriptions given here. For example, although the red pigmentation of the leaf veins may be useful for identifying some of the species in the area and habitat of this study, it may be missing from specimens collected elsewhere. Some of the species have the potential to grow to tree size, but in the disturbed site habitat conditions of this study all willow shrubs are immature, so size ranges are not given.

Descriptions of the floral parts are mainly paraphrased from Brayshaw (1976). Dorn (1975) and G. Argus, (National Herbarium, pers. comm.) were also consulted. All botanical illustrations are from Brayshaw (1976).

A diagram of a typical willow flower, illustrating the floral structures referred to in the descriptions, is provided in Appendix 1.

In the "Moose Utilization" section, references are sometimes made to winter moose browse observations in the Bulkley Valley area and the Cariboo River valley. The sources of these observations are in two studies which included a variety of habitat types in mainly undisturbed sites — the former in the SBSd (now SBSdk) and SBSe (now SBSmc) biogeoclimatic subzones, the latter in the Interior Cedar-Hemlock (ICH) biogeoclimatic zone (Roberts 1985; Roberts[3]).

In some cases, botanical authorities have held differing opinions as to the correct name for a particular type of willow. As a result, there are synonyms in the literature. This guide follows the taxonomic system of G. Argus (National Herbarium, National Museum of Natural Sciences, Ottawa). Where applicable, commonly used synonyms are provided after the species name at the head of each summary. To avoid ambiguity, the species names are cited in their complete form, including the names of the classifying authorities.

Some specimens collected in the study area may be hybrids of *Salix discolor* and *S. scouleriana* (G. Argus, pers. comm.). These specimens resemble *S. scouleriana*, but lack velvety erect hairs on the young branchlets and leaf stalks, though long silky hairs may be present.

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[3] Roberts, A. 1986. Willows of the lower Skeena and Bulkley Valleys, and their relative importance as winter food for moose. Unpublished manuscript. B.C. Ministry of Environment, Wildlife Branch, Smithers, B.C. 49 p.

***Salix barclayi* Andersson (Barclay's willow)**

Twigs reddish, purplish-brown or greenish, usually with short, weakly erect hairs, becoming shiny.

Leaves ovate-elliptic to elliptic-obvate, about 2.5-3.0 times as long as wide, tips acute to obtuse and bases obtuse to rounded; yellowish-green above and generally glaucous underneath; greenish when unfolding; sometimes developing dark patches on drying; long white-hairy on both sides at first, the young leaf stalks ± white-silky; the leaves becoming ± hairless, but sometimes retaining a few hairs on upper surface, especially along the mid-vein; dull above when dried. Margins finely toothed. Mid-vein yellow beneath. Lateral veins ± regularly spaced, not very conspicuous underneath. Stipules generally small, ovate-auriculate, finely toothed.

Catkins appearing along with the leaves in spring, terminating short leafy branchlets. Fruiting catkins about 3-7 cm long by 1.5 cm thick, the catkin axes notably long-hairy. Bract dark, long-hairy, about 1 mm long or more. One gland. Pistil usually greenish. Capsule 3-8 mm long, usually hairless, the stipe about 0.5-1.5 mm long and the style 0.5-2.5 mm long, the stigmas. Two stamens, hairless.

Site Conditions:	Subxeric to mesic sites with sandy loam soils.
Distribution:	Occasional, with low cover, on mesic sites in the SBSdw3; also a trace found on a subxeric site in the SBSm
Moose Utilization:	Light. This is an important winter forage species for moose in the Bulkley Valley area, but on disturbed sites in the area of the present study it is too rare to supply a significant quantity of moose forage.

***Salix bebbiana* Sargent (Bebb's willow)**

Young stems reddish-brown to wine-red, sometimes yellowish, and sparsely to densely hairy; becoming hairless and yellower, then greyish, with age.

Leaf blades obovate to ovate, about 2-3 times as long as wide; tips obtuse, acute or acuminate; bases rounded, obtuse or acute; yellow-green to dark green above, paler and glaucous underneath; both surfaces generally white wavy-hairy, the lower sometimes ± densely so under a hand lens. Margins entire to weakly toothed or round-toothed. Mid-vein usually pale underneath, sometimes reddish, especially toward the leaf stalk. Lateral veins usually ± conspicuous, raised and branching, the veinlets as well often conspicuously raised, producing a reticulate-wrinkled appearance; lateral and minor veins underneath creamy-pale or the same shade as the glaucous background surface. Stipules usually inconspicuous or absent; larger and toothed-auriculate on vigorous shoots.

Catkins appearing shortly before or along with the leaves, terminating short small-leaved branchlets; fruiting catkins about 3-5 cm long. Bract light brown or yellowish, hairy. One gland. Capsule 5-9 mm long, usually sparsely short-hairy. Stipe notably elongate, up to 5 mm long, the bract. Style very short or up to 0.4 mm long; stigmas up to 0.5 mm long. Two stamens, basally hairy.

Site Conditions: Subxeric to hygric sites with coarse to moderately fine soils.

Distribution: Very widespread in the study area. Most abundant on mesic and wetter sites in the drier, warmer subzones (SBSdw3 and SBSmk1); less common and less abundant in the SBSwk1 and SBSvk. The most abundant willow of the SBSdw3 and SBSmk1 plots.

Moose Utilization: This was the most important moose browse species in the SBSdw3 clearcuts (mainly by virtue of its abundance) and the second most important in the SBSmk1; of minor importance on disturbed sites in the other two subzones. *S. scouleriana* and *S. sitchensis* are regularly selected over *S. bebbiana*, when available. Elsewhere, *S. bebbiana* is heavily used in clearcuts in the Cariboo River valley and is reported to be selected over other willow species in the Bulkley Valley area.

Comments: The white-woolly undersides of the upturned leaves often impart a greyish coloration when the plant is seen at a distance. The species is notably susceptible to a branch-tip gall.

***Salix discolor* Muhlenberg (pussy willow)**

Young stems becoming hairless (sometimes initially silky-hairy), usually wine-red, reddish-brown, or purplish, then developing smooth grey bark.

Leaf blades obovate to elliptic, tips acute to obtuse or sometimes rounded, bases acute to obtuse; yellowish-green to dark green and inconspicuously hairy above, sometimes shiny; glaucous and hairless or faintly white- or red-hairy underneath, except often white-velvety on vigorous young shoots and white-silky on new spring leaves. Margins mostly shallowly toothed, round-toothed or entire, but can be ± saw-toothed. Mid-vein generally cream-colored; lateral veins seldom conspicuous underneath, somewhat irregular and branching. Leaf undersurface usually smooth, not raised-veiny (except slightly so on older leaves), the veinlets often forming a dark filigree against the glaucous background. Stipules generally tiny, but may be conspicuous on vigorous shoots, auriculate or (rarely) kidney-shaped, with toothed margins.

Catkins appearing very early in spring, before the leaves, and mostly dropping off in June; borne directly on the stems. Fruiting catkins very large, up to 12 cm long by 3 cm thick. Bract 2-3 mm long with long straight hairs. One gland. Capsule 5-12 mm long, hairy. Stipe 1.5-2.5 mm long. Style 0.3-0.8 mm long, ≤ the stigmas. Two stamens, basally short-hairy.

Site Conditions: Subxeric to subhydric sites with coarse to moderately fine soils.

Distribution: Very widespread in the study area, but not especially abundant except in the SBSdw3 plots where it is the second most abundant willow. This species favours poorly drained sites in the drier, warmer subzones, being most common and most abundant on subhygric sites in the SBSdw3 and SBSmk1.

Moose Utilization: *S. discolor* was sometimes moderately or even heavily browsed, but generally other species seem to be preferred. Only in the SBSdw3 plots was it a major winter food source. It has been found to provide considerable winter browse in the Bulkley Valley area.

Comments: *S. discolor* is often a tall, vigorous shrub. This species possibly hybridizes with *S. scouleriana* in the study area.

Salix drummondiana **Barratt in Hooker (Drummond's willow)**

Young stems dark red or purple and coated with a characteristic bluish- white waxy bloom that rubs off easily; becoming yellow-brown and smooth with age. Bud scales long, yellowish, velvety, conspicuous.

Leaf blades elliptic, lanceolate or oblanceolate, 3-6 times as long as wide, tips acute, bases acute to obtuse or ± rounded; dark green to yellow-green above and lightly hairy; often densely covered underneath with white (occasionally rust-tinged) hairs, usually flat-lying and oriented toward the tip; when the hairs long and dense, the underside having a bright reflectance and the feel of cat fur; sometimes the underside slightly glistening with inconspicuous hairs. Leaf margins usually slightly wavy (sometimes minutely toothed) and slightly rolled under. Mid-vein yellow underneath; lateral veins sometimes weak and indistinct underneath, and in any case often obscured by hairs. Stipules usually absent.

Catkins appearing before the leaves in spring, borne directly on the stems. Fruiting catkins up to 8 cm long by about 1 cm thick.

Bract dark, 1.5-2.5 cm long, long-hairy. Two glands on flower, one on flower. Capsule 4-5 mm long, hairy. Stipe 0.6-2.0 mm long. Style 1.3 mm long. Two stamens, hairless.

Site Conditions: Submesic to hygric sites with moderately coarse to moderately fine soils.

Distribution: Common on disturbed sites in the SBSdw3, occasional in the SBSmk1 and SBSwk1, rare in the SBSvk. Grows best (but only the third most abundant species) on mesic sites in the SBSdw3.

Moose Utilization: Although sometimes moderately used, *S. drummondiana* is not abundant enough in the clearcuts to supply a major component of forage. Elsewhere, it is often heavily used in the wetlands of the Bulkley Valley area and the Cariboo River valley.

Comments: *S. drummondiana* tends to form dense thickets along edges of streams and in other moist places. After leaf-drop in the fall, these thickets appear distinctly pale bluish or purplish-red from a distance, permitting ready identification even from a vehicle travelling on the highway.

***Salix farriae* C. Ball (Synonym: *S. hastata* L. var. *farrae* (Ball) Hultén) (Farr's willow)**

Twigs purplish, wine-red or rusty-red, hairless or with a few hairs ± pressed against the stem, dull-surfaced or shiny.

Leaves lanceolate to elliptic-obovate, about 3 times as long as wide, acute to obtuse at tip and obtuse to rounded at base; mature leaves yellowish-green above, the unfolding leaves reddish, especially toward the base; becoming glaucous (sometimes only weakly so) underneath; sometimes developing dark patches on drying; hairless when mature, sometimes sparsely white- or reddish-hairy above when young; dull above when dried. Margins typically finely toothed toward the leaf tips or entire, but our specimens mostly finely glandular-toothed from tip to base. Midvein yellow beneath; lateral veins ± regularly spaced, conspicuous underneath. Stipules generally small, ovate-auriculate, very finely toothed.

Catkins appearing along with the leaves in spring, terminating short leafy branchlets. Fruiting catkins 1.0-4.5 cm long. Bract bicolored or all dark, about 1-2 mm long, sparsely hairy or hairless. One gland. Pistil sometimes reddish. Capsule 3-6 mm long, hairless, the stipe 0.3-1.5(2) mm long, the style 0.4-1.2 mm long. Two stamens, hairless.

Site Conditions:	Collected on mesic and hygric sites, on silt loam and loam soils.
Distribution:	Rare in the study plots, collected in only three locations in the SBSdw3 and SBSwk1.
Moose Utilization:	Trace. This species is insignificant for moose forage on disturbed sites in our area because of its rarity.

***Salix glauca* L. var. *villosa* (Hooker) Andersson (grey-leaved willow)**

Young stems medium yellow-brown to red-orange or wine-red, hairy; mature stems yellow-brown to greyish-brown and ± hairless, often thinly papery-peeling.

Leaf blades generally elliptic but ranging from ovate to obovate or sometimes broadly lanceolate or oblanceolate, about 1.6-3.0 times as long as wide, tips obtuse to acute or acuminate, bases acute to rounded; greyish-green above (but fading or drying to yellowish-green), glaucous underneath, white-hairy on both surfaces (more so underneath and on younger leaves). Leaf margins entire to slightly wavy. Mid-vein pale underneath; lateral veins ranging from somewhat raised and wrinkled-looking underneath to not at all raised and inconspicuous, the veins and veinlets often appearing as thin darker lines against the glaucous background. Stipules (when present) elliptic-pointed, leaflike.

Catkins appearing along with the leaves in spring, terminating short leafy branchlets. Fruiting catkins up to 5 or 6 cm long; bract yellowish-brown or darker, hairy. One gland, sometimes bi-lobed; capsule densely hairy at first, sometimes becoming nearly hairless; stipe very short or up to 1.6 mm long, sometimes longer; style 0.5-1.0 mm long, sometimes divided, ≥ the stigmas. Pollen-

producing catkin fragrant. Two stamens, sometimes basally hairy, the anthers initially bright red and yellow; one or two glands and often bilobed.

Site Conditions: Submesic to hygric sites with sandy loam soils.

Distribution: Infrequent, with low cover, on submesic and mesic disturbed sites in the SBSdw3; relatively abundant on a single hygric site in the SBSmk1. A rare species in the study area.

Moose Utilization: Lightly used in one plot; evidently an insignificant food source on disturbed sites in the area of this study, because of its rarity. Not a preferred browse species in the Bulkley Valley area.

Comments: This is a rather small shrub in our area, none of the specimens found measuring more than 1.5 m tall. The female catkins may still be shedding their seeds in September and may persist on the plant until the following spring.

***Salix lucida* Muhlenberg ssp. *lasiandra* (Bentham) Boivin (synonym: *S. lasiandra* Bentham) (Pacific willow)**

Twigs at first yellow to dark red and sometimes hairy, becoming caramel-colored to chestnut brown and shiny. Bud scales large and conspicuous, yellow to caramel, hairless, shiny.

Leaf blades typically long and lanceolate-tapering, acute at tip and obtuse to rounded at base, but sometimes merely ovate-elliptic to elliptic-obovate and obtuse at tip; generally with ± prominent glands near blade base; yellowish-green to deep green above and glaucous beneath (sometimes only slightly so); bearing silky white hairs when first unfolding but soon becoming apparently hairless underneath (actually bearing minute reddish hairs). Margins finely toothed, sometimes glandular. Mid-vein yellow underneath; lateral veins closely spaced. Stipules from small, ovate-auriculate and finely toothed to large and kidney-shaped.

Catkins appearing along with the leaves in spring, terminating short leafy branchlets. Fruiting catkins up to 12 cm long, the axes hairy. Bract yellowish, hairy, usually falling off early in season. Two glands. Capsule 4-8 mm long, hairless, on a stipe ≤ 1 mm long, the style ≤ 1 mm long. Three to eight stamens , usually five, basally hairy.

Site Conditions:	Submesic to subhydric sites with moderately coarse to moderately fine soils.
Distribution:	Occurs on disturbed sites in all subzones; most abundant on wet (hygric and subhydric) sites in the SBSwk1 and SBSvk. Elsewhere only occasionally present, usually with low cover.
Moose Utilization:	Moderate to heavy use on disturbed sites in the SBSwk1 and SBSvk, where it appears to be selected over other more abundant species. Potentially an important forage species in areas where it is plentiful. Except in the SBSwk1, however, where its consumption is surpassed only by *S. scouleriana* and *S. sitchensis*, its total contribution is minor. In the SBSdw3 and SBSmk1, it is barely present and thus very little used. *S. lucida* is an important winter browse species in the Cariboo River valley.

***Salix maccalliana* Rowlee (Maccalla's willow)**

Twigs initially green and hairy, becoming reddish-brown to purplish, hairless, dull.

Leaf blades elliptic to oblanceolate, about 4 times as long as wide, acute to obtuse (rarely rounded) at tip, acute to ± rounded at base; ± shiny yellowish-green to dark green above and pale green underneath, the underside typically not glaucous, but some of our specimens noticeably glaucous; ± hairless in maturity, but reddish- or white-hairy when young; mature leaves somewhat firm to ± leathery. Leaf margins finely glandular-toothed, sometimes rolled under and then appearing entire. Mid-vein ± robust, yellow-conspicuous above and underneath, the veins and veinlets forming a conspicuous dark green network underneath against the pale green background. Stipules minute or absent.

Catkins appearing along with the leaves in spring, terminating short leafy branchlets. Fruiting catkins up to 5 cm long by 2 cm thick. Bract notably large, 3-5 mm long, yellow to pale brown and sparsely hairy. One or two glands, deeply lobed, 0.5-0.7 mm long. Capsule large, up to 12 mm long, densely hairy, on a stipe up to 2 mm long; style up to 1 mm long. Two stamens, basally hairy.

Site Conditions:	Collected on subhygric and hygric sites with sandy loam soils (typically found on organic soils in fens).
Distribution:	Very rare in the study plots; found only at two sites in the SBSdw3 and SBSmk1, with low cover.
Moose Utilization:	None noted in the study plots, probably because the species is scarce on logged sites. In undisturbed wetlands (fens) of the Bulkley Valley area, though, *S. maccalliana* can be heavily used.
Comments:	Our specimens are mostly low, spreading shrubs about 1 m tall.

***Salix myrtillifolia* Andersson var. *cordata* (Andersson) Dorn (synonym: *S. novae-angliae* Andersson) (myrtle-leaved willow)**

Branches dark reddish-, yellowish- or greyish-brown and minutely hairy, becoming yellower and hairless with age.

Leaf blades narrowly to widely elliptic to obovate, tips acute, obtuse or sometimes rounded and bases obtuse to rounded; unfolding leaves reddish and hairy, mature leaves dark green above and typically shiny on both sides, not glaucous underneath; becoming hairless or with a few short hairs on the upper surface of the mid-vein. Margins finely toothed. Mid-vein yellowish underneath. Lateral veins ± irregularly spaced. Stipules generally small and quickly deciduous, but may be ovate-prominent on vigorous shoots.

Catkins appearing along with the leaves in spring, terminating short leafy branchlets. Fruiting catkin 2-5 cm long (or longer) by 1.5 cm thick. Bract brown, 0.5-1.5 mm long, hairless or hairy. One gland, short. Capsule 3-6(7) mm long, stoutly conical, hairless, on a stipe 0.5-1.5(2.5) mm long. Style very short or up to 1-1.5 mm long; stigmas short. Two stamens, hairless.

Site Conditions:	Inhabits wet areas. Our one location is a hygric site with a loam soil.
Distribution:	Extremely rare in the study sites; only two individual plants found at a single plot in the SBSwk1.
Moose Utilization:	The plants had been lightly used, but such a rare species can supply virtually no forage.

***Salix planifolia* Pursh ssp. *planifolia* (tea-leaved willow)**

Young stems greenish-brown and sparsely hairy, becoming purplish and hairless.

Leaf blades elliptic to oblanceolate or obovate, sometimes somewhat diamond- or lozenge-shaped, tips acute or acuminate (occasionally obtuse or rounded), bases usually broadly acute; dark yellowish-green and often shiny above, glaucous underneath; white-hairy when young, becoming ± hairless (sometimes with a few reddish hairs underneath). Leaf margins usually entire, sometimes weakly or finely toothed. Mid-vein yellow underneath; lateral veins ± regularly and closely spaced in a herringbone pattern. Stipules, when present, usually small and ovate-auriculate; often absent.

Catkins appearing before the leaves in spring, borne directly on the stems or on a very short branchlet with a few very small leaves. Fruiting catkins up to 7 cm long. Bract blackish, at least toward the tip, and hairy. One gland. Capsule 5-8 mm long, hairy; the stipe very short or up to 1 mm long; the style 0.6-2 mm long, > the stigmas.

Site Conditions:	A submesic and a subhygric site with moderately coarse to medium soils.
Distribution:	Very rare in the study sites, collected only at one location in the SBSmk1 and one in the SBSvk.
Moose Utilization:	No utilization of *S. planifolia* was recorded in this study, but the species can be heavily browsed in the Bulkley Valley area.

***Salix prolixa* Andersson (synonyms: *S. mackenzieana* Barratt ex Hooker, *S. rigida* Muhlenberg var. *mackenzieana* (Hooker) Cronquist, *S. cordata* Muhlenberg var. *mackenzieana* Hooker) (Mackenzie willow)**

Young stems mostly reddish-brown to dark wine-colored, hairless, shiny, forming greyish, peeling patches in the second year, eventually becoming grey.

Leaf blades ovate, elliptic, obovate or lanceolate, 2-4 times as long as wide, tips usually acute and sometimes ± narrowly tapering, bases often rounded but ranging from acute to heart-lobed (especially so on vigorous shoots); reddish when unfolding, becoming yellow-green to dark green above, sometimes shiny; glaucous underneath; hairless. Leaf margins generally finely toothed, sometimes entire. Mid-vein conspicuous (especially underneath), often cherry-red toward the base and the leaf stalk wine-red (but rarely the mid-vein and leaf stalk merely yellow or cream); lateral veins and veinlets usually ± inconspicuous underneath (except the laterals somewhat raised up on old leaves), the leaf underside thus commonly having a smooth uniform appear-

ance; the laterals usually showing a distinct herringbone pattern when the leaf viewed against a light source. Stipules auriculate, often conspicuously large.

Catkins appearing just before or with the leaves in spring, terminating short branchlets with a few small leaves. Fruiting catkins 3-6 cm long, the catkin axes often densely tangled-hairy. Bract usually brown, basally hairy, about 1 mm long. One gland. Capsule 3-7 mm long, hairless, on a stipe 1-4 mm long; style 0.2-0.7 mm long, ≥ the stigmas. Two stamens, hairless, the filaments forking from a single basal stalk.

Site Conditions:	Mesic to subhydric sites with moderately coarse to moderately fine soils.
Distribution:	Widely distributed but never abundant, *S. prolixa* occurs sporadically on disturbed sites in all four subzones.
Moose Utilization:	Although often lightly or moderately browsed, *S. prolixa* is not abundant enough to supply much moose forage in the area of this study. It is frequently browsed in the Bulkley Valley area and heavily used in the Cariboo River valley.
Comments:	*S. prolixa* tends to have a tall, spindly habit of growth.

***Salix pyrifolia* Andersson (balsam willow)**

Stems smooth, shiny, reddish- or yellowish-brown to (most often) dark purple.

Young leaf blades thinly white-hairy and delicately membranous, shiny and translucent when unfolding, becoming ovate to obovate with acute to rounded tips and heart-lobed to rounded bases, yellow-green to sometimes purplish, up to about twice as long as wide; older leaves often elliptic to sometimes broadly lanceolate or oblanceolate, much firmer and coarser than the young leaves, ± dull-surfaced, glaucous beneath, hairless. Leaf margins finely toothed, sometimes only weakly so, or wavy rounded-toothed on vigorous shoots. Mid-vein usually cream-colored, lateral and minor veins somewhat impressed on the upper leaf surface and ± raised-reticulate underneath. Stipules initially small and soon falling off.

Catkins appearing along with the leaves in spring, terminating short (sometimes greatly reduced) leafy branchlets. Fruiting

catkins up to 9 cm long by 2 cm thick. Bract brown, thinly hairy, up to 2 mm long. One gland, minute. Capsule 4-9 mm long, hairless, purplish, on an elongate stipe up to 4 mm long, the style 0.4-1 mm long.

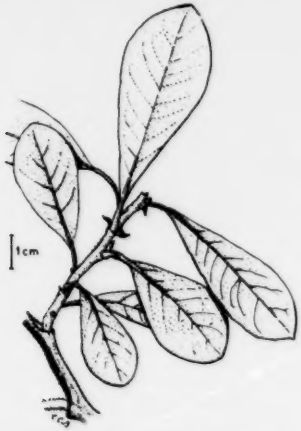
Site Conditions: Collected on submesic to hygric sites with coarse to moderately fine soils (usually grows on organic soils).

Distribution: Fairly common though seldom abundant (usually only a trace present) on disturbed sites in the SBSdw3, SBSmk1, and SBSwk1, but absent from the SBSvk. Somewhat abundant only on subhygric sites in the SBSdw3 and SBSmk1.

Moose Utilization: Frequently lightly used except in the SBSmk1, where use of this species was not recorded. The low abundance of *S. pyrifolia* makes it a relatively unimportant forage source on logged sites in wetlands of the area of this study. It is a heavily to severely browsed species in wetlands of the Bulkley Valley area and is used in the Cariboo River valley wherever it occurs.

Comments: This is a robust shrub that sometimes has a balsamic fragrance, like cottonwood.

***Salix scouleriana* Barratt in Hooker (Scouler's willow)**



Stems yellow, green, brown or reddish, the young twigs velvety with short white hairs, older stems smooth and eventually grey-barked; vigorous shoots often densely velvety on the stems and leaf undersides.

Leaf blades obovate, elliptic, or broadly oblanceolate, sometimes weakly spatulate, 2-4 times as long as wide; tips ranging from rounded to acute-pointed, bases acute to obtuse; dark green above and ± shiny in fresh material, glaucous underneath; leaves white-hairy when young, and often densely woolly-velvety and somewhat rust-tinged on vigorous shoots; older leaves becoming ± hairless above; on the underside the hairs becoming sparser and more distinctly rust-colored, the coloration sometimes readily apparent even at a distance, the reddish hairs often concentrated along the veins or in small points (but sometimes the undersides hairless). Leaf stalks with short, erect velvety hairs visible with a hand lens. Margins generally entire, wavy or weakly round-toothed, more strongly toothed on vigorous shoots. Mid-vein pale underneath; lateral veins often pale and thinly raised up underneath. Stipules generally small or absent, but large, auriculate-pointed and toothed on vigorous shoots.

Catkins appearing very early in spring, before the leaves, and

borne directly on the stems; mostly dropping off in June. Fruiting catkins 2-6 cm long by 1-1.5 cm thick, often somewhat drooping. Bract dark, 4-5 mm long, with long straight hairs. One gland. Capsule 5-8 mm long, hairy. Stipe 0.8-2.0 mm long. Style 0.2-0.6 mm long, ≤ the stigmas. Two stamens, hairless or basally sparse-hairy.

Site Conditions: Subxeric to subhydric sites with coarse to moderately fine soils.

Distribution: *S. scouleriana* is very common on disturbed sites throughout the study area and often very abundant. It favours drier sites generally, being most common and abundant on submesic and mesic sites in the SBSmk1 and SBSwk1. This is the second most abundant willow in the SBSwk1 and SBSvk plots (after *S. sitchensis*). *S. scouleriana* has aggressively colonized some extensive burned areas in the Bowron Valley.

Moose Utilization: Often moderate, sometimes heavy. Moose appear to select this species over all others except the relatively uncommon *S. lucida* and, in the wetter subzones, the very abundant *S. sitchensis*. In disturbed areas of the SBSmk1 and the SBSwk1 it contributes more forage than any other species. It is also a preferred browse species in the Bulkley Valley area, and provides an abundance of forage in the Cariboo River valley.

Comments: Some of the specimens collected lack the characteristic short, erect velvety hairs on the leaf stalks and may represent hybrids with *S. discolor*. *S. scouleriana* is sometimes found growing as a small tree in the forest understory in the area of this study.

***Salix sitchensis* Bongard (Sitka willow)**

Young stems brownish to dark red or purple, velvety, becoming chestnut brown and shiny-hairless with age, then grey.

Leaf blades elliptic, obovate, oblanceolate, or broadly spatulate, 2.0-3.5 times as long as wide; tips acute, obtuse or rounded, bases acute to obtuse or ± rounded; dark green and short-hairy above, non-glaucous and densely covered with short white hairs underneath, the underside thus having a characteristic satiny or pearly lustre. Leaf margins faintly toothed and wavy, bearing small glands, and slightly rolled under. Mid-vein conspicuously yellow, rose or wine-red underneath; lateral veins robust and raised underneath, conspicuously yellow or rose-colored, branching from the mid-vein in a strongly marked, regular herringbone pattern. Stipules auriculate-rounded.

Catkins appearing before or along with the leaves in spring, terminating short leafy branchlets; generally retained until July. Fruiting catkins 3-8 cm long, slender. Bract brown (darker at the apex), long-hairy, 1.5-2.4 mm long. One gland. Capsule 3.5-5.5 mm long, densely shiny-hairy, on a stipe 0.5-1.4 mm long. Style 0.3-1.2 mm long, ≥ the stigmas. One stamen, stout, hairless.

Site Conditions:	Submesic to subhydric sites, on coarse to moderately fine soils.
Distribution:	Infrequent, with low cover, on disturbed sites in the SBSdw3 and SBSmk1; very common in the SBSwk1, where it is most abundant on the wetter sites; almost universally abundant in the SBSvk plots. Evidently favours wetter, cooler, more poorly drained sites. The most abundant willow species in the SBSwk1 and SBSvk plots.
Moose Utilization:	*S. sitchensis* is scarce and not much used in the SBSdw3 and SBSmk1, but is abundant and moderately to sometimes heavily browsed on disturbed sites in the SBSwk1 and SBSvk. *S. sitchensis* supplies much more forage than any other willow in the SBSvk plots, and about as much as *S. scouleriana* in the SBSwk1. Elsewhere, it is often used heavily in the Cariboo River valley.

8 FACTORS AFFECTING WILLOW SPECIES DISTRIBUTION AND ABUNDANCE

8.1 Relative Importance of the Different Species

On the basis of their distribution and abundance, the willow species of disturbed sites in the study area can be divided into three groups:

1. four species — *Salix bebbiana*, *S. discolor*, *S. scouleriana*, and *S. sitchensis* — which are common on disturbed sites in all four subzones and in a variety of ecological site conditions. These are often abundant at a site, and have relatively high total cover values.
2. four more species — *S. drummondiana*, *S. lucida* ssp. *lasiandra*, *S. prolixa*, and *S. pyrifolia* — which occur fairly commonly on disturbed sites in three or more of the subzones. They are seldom abundant at a site and have low total cover values compared to the first group.
3. six species — *S. barclayi*, *S. farriae*, *S. glauca* var. *villosa*, *S. maccalliana*, *S. myrtillifolia* var. *cordata*, and *S. planifolia* ssp. *planifolia* — which were found at only a few sites and in no more than two of the subzones. They are apparently never very abundant on disturbed sites, and have very low total cover values.

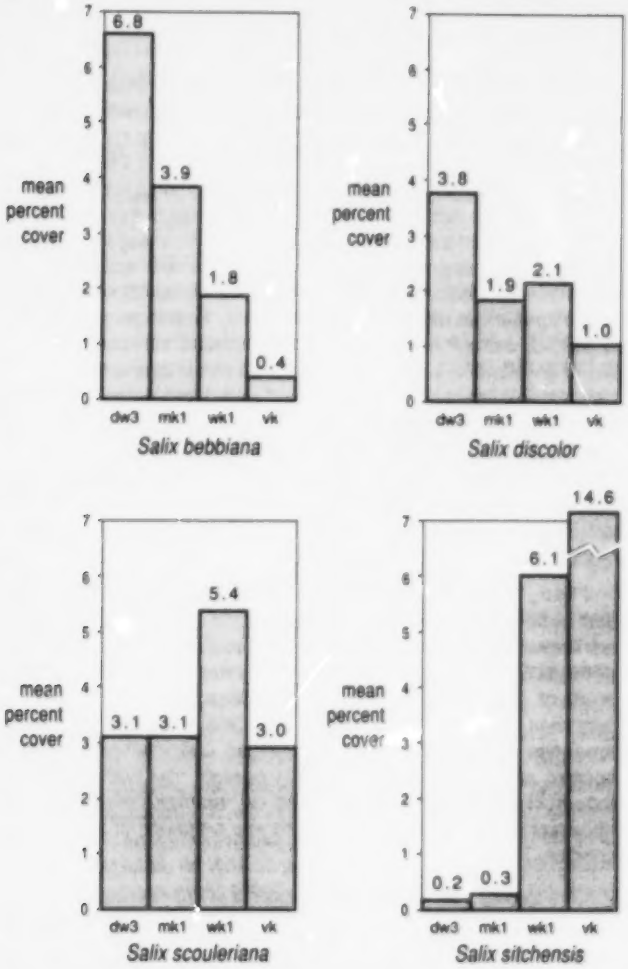
Species of the first group contributed 83% of the total willow cover in the SBSdw3 and SBSwk1 plots, 89% in the SBSmk1 plots, and 96% in the SBSvk plots. These are the common, relatively abundant willows that can form a significant component of the brush species complex that competes with young conifers in disturbed sites, as well as offer major value as moose forage. Species of the second group can present local brush problems and locally significant amounts of moose browse. Species of the third group are probably too rare and too low in cover on disturbed sites to provide significant competition to conifers or meaningful amounts of moose forage.

8.2 Biogeoclimatic Gradient

Figure 2 shows the disturbed-site abundance (mean percent cover per plot) in each subzone of the four common willow species of the first group described above. (The remaining species have such low mean cover values, often much less than 1%, that it did not seem useful or meaningful to graph them.) With the subzones arranged in the order of a climatological gradient, from relatively dry and warm on the left of the figure to relatively wet and cool on the right, two opposing species responses are apparent. *S. sitchensis* increases dramatically from the SBSdw3, where it is a minor species, to the SBSvk, where it is by far the most important willow; *S. bebbiana* and *S. discolor* decrease steeply along the same gradient. *Salix scouleriana*, however, shows a distribution pattern peaking in the SBSwk1, which is not explainable in terms of response to the climatological gradient. (In this and the other subzones, a relatively small number of plots occur with high cover values of *S. scouleriana*, sometimes related to site burning. Perhaps simply by chance, there are more such plots in the SBSwk1 than in the other subzones, resulting in a peak of mean cover of *S. scouleriana* in that subzone.)

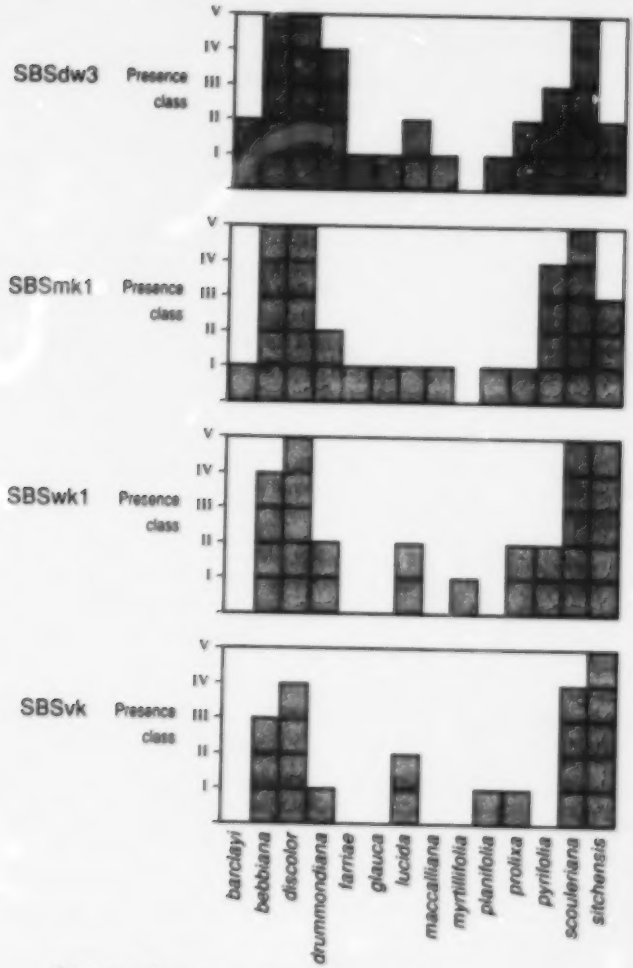
Figure 3 profiles the willow species composition in each of the four subzones. The changing proportions of the willow species are apparent, as *S. bebbiana*, *S. discolor*, *S. drummondiana*, and perhaps *S. scouleriana* become less common along the subzone gradient from the SBSdw3 to the SBSvk, while *S. sitchensis* becomes more common. These qualitative trends in species presence follow the same direction as quantitative trends in species abundance as measured by percent cover (cf. Figure 2), though the strong trends revealed by species cover are less apparent when one examines the simple presence or absence of species.

One overall trend apparent in Figure 3 is the decreasing willow species diversity along the subzone gradient. Thirteen willow species occur in the SBSdw3 and SBSmk1 plots, nine in the SBSwk1, and eight in the SBSvk.



dw3 = SBSdw3; mk1 = SBSmk1; wk1 = SBSwk1; vk = SBSvk

FIGURE 2. Willow species abundance profiles: mean percent cover by subzone of the four most abundant willow species on disturbed sites.



Presence classes: *(% presence of species in plot)*

I: 1-20%; II: 21-40%; III: 41-60%; IV: 61-80%; V: 81-100%.

FIGURE 3. Subzone willow composition profiles: presence class of each species on disturbed sites in each subzone.

8.3 Soil Moisture Regime

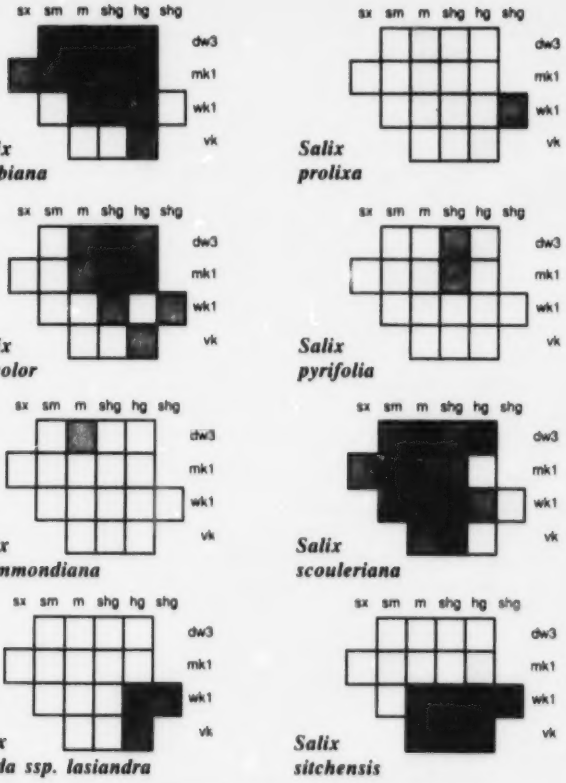
To examine the performance of different species in different habitat types, an index of performance was devised, combining distribution and abundance factors. Species constancy in a habitat type (i.e., the percentage of plots of that type in which the species was found) was multiplied by the mean percent cover of the species in the plots of the type. Possible values of the index range from zero (species not present in the type) to 100 (species present with 100% cover in all the plots of the type). Actual values ranged as high as 22. Performance index classes of the eight most common willow species (groups 1 and 2 as described in section 8.1) are plotted in Figure 4 for each ecological moisture regime category (hygrotope) in each subzone. (For the six rare species, there are not enough data records for a presentation of this type to be meaningful.)

The diagrams reveal clear patterns of distribution and abundance related to soil moisture as well as climate. Interpretations follow for the four major species.

Salix bebbiana and *S. discolor* show similar ecological performance patterns. *Salix discolor* was found on disturbed sites in every hygrotope in every subzone, and *S. bebbiana* occurred in all but the single subhydric site. Both perform best in the wetter, more poorly drained sites in the drier, warmer subzones; *S. discolor* in particular is sparse on the drier sites within each subzone. These species evidently thrive in a combination of moist rooting environment and a relatively dry, warm growing season.

Salix scouleriana, like *S. discolor*, may be found on any type of disturbed site in the study area, but prefers the drier sites. Only in the wettest locations is it relatively uncommon. There is no obvious climatic factor affecting the performance of this species within the range of the four subzones studied; ecological moisture regime appears to be the important determinant of *S. scouleriana* performance.

Salix sitchensis performs extremely well on disturbed sites in the very wet, cool SBSvk; performs somewhat less well, though it is still common and abundant, in the wet, cool SBSwk1; and performs comparatively poorly in the drier, warmer subzones. The main determinant of *S. sitchensis* performance in the study sites is clearly climatic — a need for a rainy, cool growing season.



Performance Index (0-100)= constancy (0-100%) x mean % cover (0-100%)

Biogeoclimatic subzones:

dw3 = SBSdw3; mk1 = SBSmk1;
wk1 = SBSwk1; vk = SBSvk

Ecological moisture regime classes:

sx = subxeric; sm = submesic; m = mesic;
shg =subhygric; hg = hygric; shd = subhydric

FIGURE 4. Ecological performance diagrams: performance indices by subzone and by ecological moisture regime of the eight most common willow species of disturbed sites.

Within the SBSwk1, this species shows a trend to stronger performance on the wetter sites, but in the SBSvk, soil moisture regime does not seem to matter much.

The ecological amplitudes of the willow species may be somewhat broader in the early seral stages represented by this study than in more mature communities. Species such as *S. discolor* and *S. scouleriana*, for example, which might be expected to show more habitat differentiation (the former on wetter sites, the latter on drier), are here frequently found growing side by side. Several species found growing on submesic sites are hardly typical of such sites, but would be expected in wetter places. Presumably willow seeds colonizing fresh substrate can germinate and grow in a wide variety of soil moisture regimes and other site conditions, but local ecological conditions and competitive interactions will eventually select some species over others.

8.4 Site Disturbance History

Freshly prepared sites may be colonized by willows as a result of wind-seeding or sprouting from mechanically damaged roots and stems. Wildfire, mechanical site preparation (discing), brush cutting, or combinations of these all appear to have promoted rapid and vigorous willow sprouting at various sites in the study area.

For example, one large area that was burned by wildfire in 1985 had become dominated by *S. scouleriana* by 1987. In 1988, *S. scouleriana* shrubs up to 2 m tall covered up to 40% of some parts of the area. Another area burned by wildfire in 1961 was disced in 1983 and 1984. The large, previously existing willow crowns have re-sprouted and, by 1988, *S. scouleriana* up to 2 m tall covered 22% of the site. A third area planted with spruce in 1972 had become densely covered with large willows by 1986, when they were power-sawed. The first season's regrowth of the cut willows sometimes reached over 2 m tall. In 1988, *S. scouleriana* and *S. discolor* over 2.5 m tall covered 20% of the site.

8.5 Other Site Factors

Other factors such as soil texture, aspect, slope, elevation, and topography presumably influence willow distribution and abun-

dance to the extent that they contribute to ecological moisture regime, but no effect associated with any of these factors alone was noted.

Soil textures ranged from sands to clay loams, with most sites having sandy loam or loam soils. Slopes were mostly under 10%, elevations ranged from 672 to 978 m, and other factors varied. In the early seral stages represented in the disturbed sites it is likely that these factors had little direct effect on willow germination and growth.

8.6 Summary

Four willow species — *S. bebbiana*, *S. discolor*, *S. scouleriana*, and *S. sitchensis* — are common and abundant in most parts of the study area, causing most of the willow brush problem for conifer plantations and providing most of the moose forage. These and other species vary in abundance along a climatic gradient, with *S. bebbiana*, *S. discolor*, and *S. drummondiana* being most common and abundant in the SBSdw3 (driest, warmest) and least so in the SBSvk (wettest, cool). *Salix sitchensis* showed the opposite trend, and *S. scouleriana* peaked in the SBSwk1, while being evenly distributed in the other three subzones. Willow species diversity decreases along the gradient from drier and warmer to wetter and cooler.

Ecological moisture regime is a major factor affecting willow species distribution and abundance. *Salix bebbiana* and *S. discolor* perform best on wetter sites in the drier, warmer subzones; *S. scouleriana* prefers drier sites generally; and *S. sitchensis* thrives in the wetter, cooler subzones with some preference for wetter sites.

Wildfire, mechanical site preparation, and brush cutting all appear to have stimulated vigorous willow sprouting at different sites.

Factors including soil texture, aspect, slope, elevation, and topography do not appear to have influenced willow species abundance and distribution except presumably as they contribute to ecological moisture regimes.

9 WINTER BROWSING OF WILLOWS BY MOOSE

To derive estimates of the absolute and relative values of the various willow species as winter moose browse, the field data (see "Methods") were treated as follows. First, for each species, the browsing intensity rating recorded in each plot (a value ranging from 0 to 5) was multiplied by the percent cover recorded in the same plot (a value ranging from 0 to 100). Second, the products for each species were summed for all the plots in a subzone to produce a utilization value. Third, since these values are not comparable among subzones because of the variation in number of plots from one subzone to another, each species utilization value was then divided by the number of plots in its subzone to yield a mean utilization value per plot (a value ranging from 0 to 500). These mean utilization values are given in Table 1, as well as totals by subzone. The mean utilization values will be roughly proportional to biomass consumed (although no attempt was made to quantify this ratio). Finally, the utilization value for each species was divided by the total value for all willow species in the subzone to give the proportion of total willow utilization represented by that species. These quantities, expressed as percentages, are also given in Table 1.

The table shows that five willow species represented almost all the willow biomass used by moose in logged areas. In the SBSdw3, *S. bebbiana*, *S. scouleriana*, and *S. discolor* made up 81.9% of total willow forage; in the SBSmk1, *S. scouleriana* and *S. bebbiana* made up 91.1%; in the SBSwk1, *S. scouleriana*, *S. sitchensis*, and *S. lucida* ssp. *lasiandra* made up 88%; and in the SBSvk, *S. sitchensis* and *S. scouleriana* made up 89.4%.

The mean utilization values appear to be strongly related to the amount of each species present. Abundant species were heavily used, while species with less than 1% cover in a plot were seldom used. Some other factors, however, were apparently involved in forage species selection. *Salix scouleriana* in every subzone, and *S. lucida* ssp. *lasiandra* in the SBSwk1 and SBSvk, appear to have been selected preferentially over *S. bebbiana* and *S. discolor* when they were present in the same plot.

The concept of preference is not further addressed here, as it could not be adequately examined in a survey study such as this

TABLE 1. Utilization values of the willow species of disturbed sites as winter moose browse

Salix spp.	SBSdw3		SBSmk1		SBSwk1		SBSvk	
	Mean U.V. per plot[a]	% of total willow utilization[b]	Mean U.V. per plot[a]	% of total willow utilization[b]	Mean U.V. per plot[a]	% of total willow utilization[b]	Mean U.V. per plot[a]	% of total willow utilization[b]
S. barclayi	0.1	0.3	0.1	0.1	*[c]	*	*	*
S. bebbiana	8.8	33.3	5.1	32.2	1.0	2.6	0.4	1.3
S. discolor	5.7	21.7	1.4	8.7	1.7	4.5	1.1	3.4
S. drummondiana	1.9	7.3	0	0	0.3	0.7	0.2	0.7
S. farriae	0.2	0.6	0	0	*	*	*	*
S. glauca	0.2	0.6	0	0	*	*	*	*
S. lucida	0.8	2.9	0	0	7.4	19.7	1.5	4.8
S. maccalliana	0	0	0	0	*	*	*	*
S. myrtillifolia	*	*	*	*	0	0	*	*
S. planifolia	0	0	0	0	*	*	0	0
S. prolixa	0.1	0.1	0	0	1.4	3.6	0.2	0.5
S. pyrifolia	1.3	5.1	0	0	0.2	0.6	*	*
S. scouleriana	7.1	26.9	9.3	58.9	13.7	36.5	5.7	18.2
S. sitchensis	0.3	1.3	0	0	11.9	31.8	22.4	71.2
Total	26.5	100.1	15.9	99.9	37.6	100.0	31.5	100.1

[a] U.V. = Utilization Value = sum of (species utilization field rating [0-5] x species percent cover [0-100]) in all plots in the subzone.
[b] = U.V. of species divided by sum of U.V.'s of all willow species in the subzone, expressed as percentage.
[c] * = indicates species not present.

one. Moose have a large number of potential reasons for selecting one species over another — reasons having to do with nutrition, palatability, efficiency of access, snow depth, habitat type, presence of other forage species nearby, season of use, and so on. At any given site a unique combination of reasons will prevail. The expressed preference of a moose in an uncontrolled setting is thus highly circumstantial. Controlled studies would be needed to produce meaningful data on selective preference.

A comparison of patterns of willow use in logged areas in the different subzones, as shown in Table 1, indicates that utilization is roughly proportional to the percent cover of each species in each subzone (cf. Figure 2). The overall intensity of willow browsing varied among the subzones, as indicated by the subzone total mean utilization values. Substantially less willow use occurred in the SBSmk1 than in the other subzones, and substantially more use in the SBSwk1. Plot location may have affected these results. For example, it is known that the area where plots were located in the SBSmk1 is not heavily used by moose in winter (D. King, Ministry of Environment, Prince George, pers. comm.). The SBSmk1 shows a peculiar pattern of use, whereby only 4 of 13 species present were used at all, and 1 of these (a rare one) only slightly. In the other subzones, almost all species present were browsed. This may be partly due to the fact that the unused species in the SBSmk1 have generally very low cover values, although species with comparably low cover values in the other subzones were generally browsed to some degree.

In conclusion, moose appeared to select willow species for browsing mainly on the basis of availability, although some unknown preference factors appear to have been operating as well. In a given subzone, two or three species out of a group of five (*S. bebbiana*, *S. discolor*, *S. lucida* ssp. *lasiandra*, *S. scouleriana*, and *S. sitchensis*) generally provided 80-90% of the forage. The only species consistently providing a major amount of forage in logged areas in all subzones was *S. scouleriana*. Overall, willow browsing intensity varied by a factor of about 2.5 between the lowest (SBSmk1) and the highest (SBSwk1).

10 WILLOW PHENOLOGY

The phenological diagrams in Figure 5 illustrate for each subzone the growth and development stages of the four major willow species of the study sites over the course of the 1988 growing season.

Two types of variation are evident from the diagrams: 1) differences in timing of flowering among the willow species; 2) differences among the subzones in the timing of both vegetative and reproductive development. In addition, the general earliness of willow flowering is noteworthy.

Much of the floral development of the willows was already completed by the May 15 start of data recording. For this reason, the full-bloom stage of the early-flowering species, *S. discolor* and *S. scouleriana*, was mostly missed. In all cases, however, catkins remained on the plants at least until early June, permitting specimens with technically identifiable floral material to be collected until at least that late in the season. (*Salix scouleriana* was not observed to flower in the phenology plots in the SBSdw3.) Catkins of *S. bebbiana* and *S. sitchensis* remained on the plants at least until late June and usually well into July.

Seed dispersal generally began in May for *S. discolor* and *S. scouleriana* and in early June for *S. bebbiana* and *S. sitchensis*, and was mostly completed in June for all species. This phase was completed earlier and was of briefer duration in the SBSvk than in the other subzones.

Reproductive development and the growth stages of vegetative development generally began and ended somewhat earlier in the SBSwk1 and SBSvk than in the other two subzones, while leaf senescence appears to have progressed somewhat more rapidly in the SBSdw3 and SBSmk1. The season of full green leaf expansion and presumably greatest productivity began later and ended earlier in the SBSdw3 than in the other subzones, while it began earlier and ended later in the SBSwk1. The pattern among the subzones, then, appears to be a briefer growth period but a more prolonged flowering period towards the drier, warmer end of the subzone gradient, and a more prolonged growth period but an earlier and briefer flowering period toward the wetter, cooler end

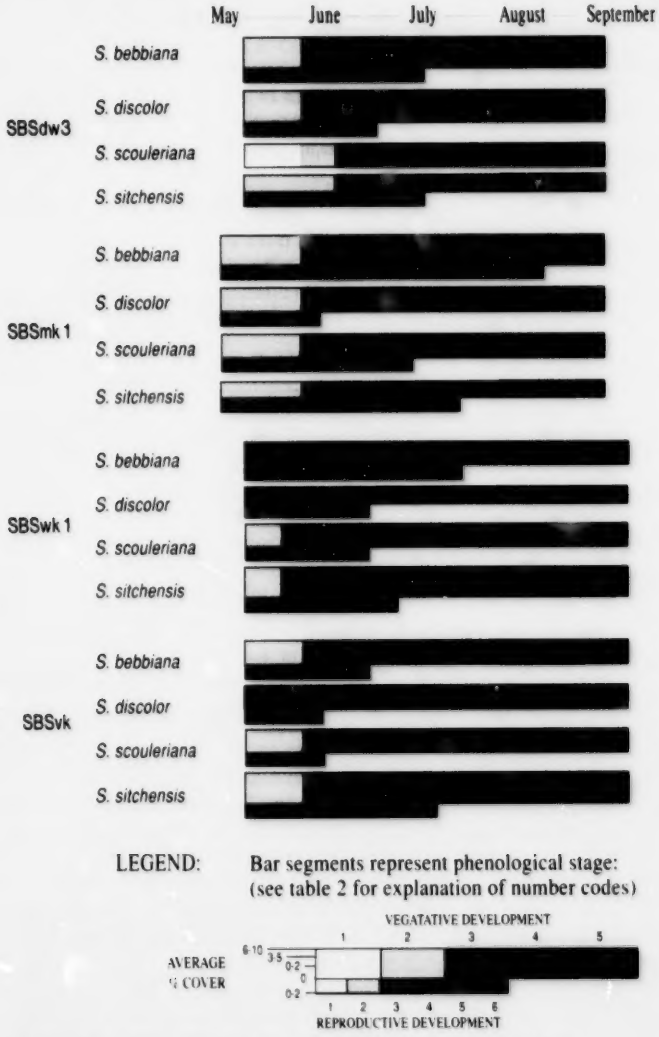


FIGURE 5. Phenological diagrams by subzone of the four most abundant willow species of disturbed sites.

TABLE 2. Coding system for recording phenological data (modified after Ellenberg (1954) cited in Dierschke (1972))

Vegetative development		Reproductive development	
1	leaves emerging from buds	1	catkins developing
2	leaves partially expanded	2	partial flowering
3	leaves fully expanded	3	full bloom
4	first leaves turning yellow	4	fruits developing
5	leaf yellowing advanced	5	seeds dispersing
		6	catkins persisting

of the gradient. The factors specifically responsible for these trends could not be isolated in weather station data, and remain unidentified. It is also not known whether the same patterns would be sustained over more than a single growing season.

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12 GLOSSARY

Acuminate	narrowing abruptly toward the pointed tip (margins concave below the tip)
Acute	making an angle of less than 90°
Anther	the pollen-producing organ on the end of a stamen
Auriculate	earlike
Autecology	the branch of ecology dealing with the relationships between living things and their environment
Blade	the wide part of the leaf, borne (in willows) on a stalk
Bract	a small scalelike or leaflike structure at the base of a willow flower
Capsule	the dry fruit of the willow, which splits open to release the seeds; many are borne on each catkin
Constancy	the number of plots in which a given species occurs (expressed as a percentage)
Cover	the area covered by a vertical projection of aboveground vegetation onto the ground surface
Elliptic	having the shape of an ellipse; a somewhat elongated figure widest at mid-length
Entire	lacking teeth or notches; forming a smooth line
Gland	a small stalklike or globular appendage
Glandular	bearing glands
Glaucous	pale greyish, whitish, or bluish green
Hygric	having a wet ecological moisture regime (see Hygrotope)
Hygrotope	ecological moisture regime; "signifies on a relative scale the available moisture supply to plant growth" (Walmsley et al. 1980)

Lanceolate	long, narrow and tapering, widest at or below mid-length
Lateral vein	one of the leaf veins which branch toward the margins from the mid-vein
Loam	a medium-textured soil consisting of ± even portions of sand, silt, and clay
Margin	the edge of the leaf blade
Mesic	having soils with an amount of available moisture normal for the climate (see Hygrotope)
Mid-vein	the central main vein of the leaf
Oblanceolate	long, narrow, and tapering, widest beyond mid-length
Obovate	egg-shaped, widest beyond mid-length
Obtuse	making an angle greater than 90°but less than 180°
Ovary	the floral organ inside which the seeds develop
Ovate	egg-shaped, widest below mid-length
Phenology	the study of the timing, duration, etc., of seasonal developmental changes in plants or other living things
Pistil	the entire fruiting portion of a flower, consisting of stigma, style, ovary, or capsule, and stipe
Reticulate	netlike
Senescence	the stage of growing old or withering
Seral	having to do with the earlier, pre-climax stages in the succession of plant (or biotic) communities at a site
Spatulate	shaped like a spatula; rounded at the tip and narrow towards the base
Stamen	a stalked pollen-bearing structure, terminating in an anther
Stigma	the sticky terminal portion of the fruiting part of the flower; supported by the style
Stipe	the stalk supporting the ovary or capsule

Stipule	one of the small paired leaflike appendages arising at the base of the leaf stalk
Style	the stalk terminating the ovary or capsule, supporting the stigma
Subhydric	having a very wet ecological moisture regime (see Hygrotope)
Subhygric	having a moist ecological moisture regime (see Hygrotope)
Submesic	having a moderately dry ecological moisture regime (see Hygrotope)
Subxeric	have a dry ecological moisture regime (see Hygrotope)
Translucent	transmitting light; i.e., appearing bright when viewed against a light source

13 EXPLANATION OF SYMBOLS

± more or less

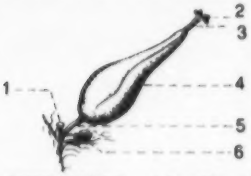
< less (fewer, smaller, shorter) than

> greater (more, bigger, longer) than

≤ less than or equal to

≥ greater than or equal to

APPENDIX 1. Diagram of a willow flower, illustrating key structures



Key to Structures

1. Nectar gland
2. Stigma
3. Style
4. Capsule
5. Stipe
6. Bract

APPENDIX 2. Identification guide to the willow species of disturbed sites

This section is supplied to familiarize the reader with the willow species that were found in more than one location on disturbed sites in the study area. It may serve as a quick, rough guide for identifying the species, though it is not a reliable substitute for the key, or for the detailed species descriptions provided elsewhere in this manual.

Salix barclayi: leaves greenish when unfolding, becoming somewhat egg-shaped, about 2.5-3.0 times as long as wide; margins finely toothed; stipules generally small. Occurs on drier sites in warmer subzones. Rare.

S. bebbiana: leaves more or less egg-shaped and pointed at the tip, entire or weakly toothed, generally with white hairs (not reddish) on both surfaces; lateral veins and minor veinlets on underside of leaf usually pale, often raised up in a reticulate pattern; fruits on long stalks.

S. discolor: stems and undersides of mature leaves essentially hairless, margins mostly entire or shallowly toothed; fruiting catkins very large, shed early in season.

S. drummondiana: young stems dark red or purplish and coated with a pale waxy bloom; leaves more or less long and narrow, often densely white- or reddish-hairy and somewhat satiny underneath; lateral veins on leaf undersides generally inconspicuous. Shrubs often form streamside thickets.

S. farriae: resembles *S. barclayi* but leaves reddish when unfolding, especially toward the base, and becoming more elongate. Rare.

S. glauca var. *villosa*: leaves mostly ± elliptic, white-hairy on

both surfaces, the margins entire; lateral leaf veins and veinlets often appearing as thin dark lines underneath against the pale background. Catkins very persistent on the plant. Rare.

S. lucida ssp. *lasiandra*: mature leaves generally long and tapering to a point, with finely toothed margins and no hairs visible underneath without magnification; small glands at the juncture of the leaf blade with the leaf stalk; stipules usually large; bud scales large, smooth, yellowish.

S. maccalliana: leaves elliptic and elongate, about 4 times as long as wide, usually with toothed margins, typically lacking dull pale bloom underneath, thus green and ± shiny; lateral veins and veinlets forming a conspicuous dark green network underneath against the pale background. Rare.

S. planifolia ssp. *planifolia*: closely resembles *S. discolor*, but lateral leaf veins are more narrowly and regularly spaced in a parallel herringbone pattern. Rare.

S. prolixa: stems and leaves hairless, the leaf margins mostly finely toothed, the bases of the leaf blades often more or less heart-lobed; mid-vein of leaf often cherry red underneath, especially toward the leaf base; stipules usually large; tall, spindly growth habit.

S. pyrifolia: young leaves delicately membranous and translucent, mostly yellowish (sometimes reddish), egg-shaped with rounded or heart-lobed bases and finely toothed margins; older leaves more elongate; lateral veins and minor veinlets ± raised up underneath in a reticulate pattern; stipules usually inconspicuous.

S. scouleriana: leaves generally wider toward the tip, which is often more or less rounded; young leaves velvety or woolly; mature leaves with at least some short rust-colored hairs underneath, often concentrated along the veins or in small points; leaf margins mostly entire or weakly toothed; leaf stalks and young twigs short-velvety.

S. sitchensis: undersides of leaves densely covered with short white hairs which impart a pearly lustre; leaf lateral veins showy underneath, raised and yellow- to rose-colored, branching off from the mid-vein in a conspicuous herringbone pattern; young stems velvety.